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ABSTRACT

As part of a cooperative extension service series by the University of Maryland, this publication introduces the identification and control of common agricultural pests of vegetable crops. The first of the five sections defines "pest" and "weed" and generally introduces different kinds of pests in the categories of insects, weeds, and diseases. Also in this section, pest control methods are introduced. The second section is a tabular listing of vegetable crop plant diseases including information on "description and damage" and on "control and management practices." The third section is a tabular listing of insect pests including "description and damage," "life cycle," and "control and management practices" information. The fourth section lists the weeds that compete with vegetable crops in Maryland including the same categories of information as the previous section. The fifth section is a collection of line drawings of these weeds. (MR)

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COOPERATIVE EXTENSION SERVICE • UNIVERSITY OF MARYLAND • COLLEGE PARK, MARYLAND

VEGETABLE CROP PESTS

MEP 311

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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WHAT IS A PEST?

Plants or animals that are directly detrimental to man or interfere with his goals and interests are commonly called pests. Included are plant and animal diseases, insects (plus mites, ticks and spiders), weeds and vertebrates (mice, some birds, some predatory mammals).

Certain pest organisms are competitors with man while others are simply nuisances or annoyances. A select number of predators, parasites and disease organisms are a serious threat to humans and domesticated animals. Many pests have an indirect influence, such as insects that carry infectious microorganisms. Others are harmful because they interfere with commodity production. They may do damage to a crop or destroy stored products and materials.

Farming practices often aid the establishment of pest species. The one-crop system of agriculture, where susceptible crops are grown and livestock are grazed on the same area continuously over the years, encourages the buildup of certain pests. The pest is provided with a good supply of host plants or animals and can multiply to harmful levels.

Man sometimes moves crops, along with their pest organisms, into new areas. Naurally occurring predators may not be found at this new location, and therefore, the pest is allowed to flourish. In other cases, the natural predators of the pest have been removed.

There are numerous pest species in competition with man, and so far, there are none which he has been able to eradicate completely. Man can only attempt to control these organisms and keep their damage to acceptable levels.

INSECTS

GENERAL

Arthropoda is the largest group in the animal kingdom and includes organisms such as lobsters, crabs, crayfish, millipedes, spiders, scorpions, mites and a special class called insects. This class contains butterflies, bees, ants, flies, aphids, and many more. By pure numbers, the *Arthropoda* are the dominant form of animal life on earth, with millions contained in almost every acre of land. Fortunately, only a small portion are serious pests to man's interests. Insects, as a class, are the most adaptable of all animals. They can be readily found living in the earth's extremes of heat, cold, drought and darkness.

Beneficial species pollinate ornamental flowers and many agricultural crops thus providing us with many of our fruits and vegetables. They work in many specialized areas such as the production of silk and honey, and they also serve as a food source for many higher animal forms.

Some insects pose a real threat to man, either directly or indirectly. The damage to crops, stored products, man-made structures, and the health of man and animals is sometimes tremendous. Many insects can be the vectors of livestock and human diseases while others damage man-made structures or eat foodstuffs. Still others are undesirable because they are a general nuisance to man in his day-to-day activities.

STRUCTURE

An adult insect's body is elongated and divided into three regions, the head, thorax and abdomen. The eyes and antennae are located on the head, and the legs and wings are connected to the middle region, the thorax. All adult insects have six jointed legs, and these are sometimes used for identification purposes since they can vary slightly between species. The adult may have no wings or be equipped with one or two pairs.

Wings and mouthparts are most important in identification. Some insect mouthparts are designed for chewing while others are adapted for piercing a food source and sucking out the nutrient material.

The insect's body is surrounded by a hardened material which not only protects the internal organs but also acts as the insect's skeleton (exoskeleton). Breathing is done through a series of tubes that travel from the body surface to the internal areas, allowing oxygen from the outside to travel directly to the tissues.

GROWTH AND DEVELOPMENT

As an insect matures, it grows in size and often changes form. The rigid shell that covers the body and protects the insect as an exoskeleton will expand only so far. This exoskeleton must be shed at intervals to allow for the growing process. This shedding or "molting" process can occur many times as the organism matures. Before the old shell is cast aside, a new one, which will allow for growth, is already being formed underneath the old.

Insects, between these successive molting processes, are called "instars", and with each molt, the insect will differ in size and form from the preceding instar. This changing process will continue until the adult form is reached. Almost all insects change in shape and size as they mature, and this development process is referred to as metamorphosis.

METAMORPHOSIS

All insects carry on these growth and molting processes, and the successive instars differ in form and size. Some insect species show little variation as they mature, changing only in size. Others undergo an extreme transition where the adult fails to resemble the young insect in any way. This is evidenced by the development of caterpillars into butterflies. Every species follows one of these developmental series of events or a process that falls somewhere between the two.

A small number of insect species develop without any gross changes whatsoever. As they develop, they change only in size. The adult insect lays eggs, and the newly hatched young look just like miniatures of the adult. As the young insects grow, they proceed through a series of molts, maintaining their basic appearance, but increasing in size. Some of these insect species that reach maturity without going through metamorphosis also add additional body segments as they mature. Common examples of these are the silverfish and springtails.

GRADUAL METAMORPHOSIS: Species that are characteristic of this type of development differ from the preceding process in that the eggs hatch into nymphs. The maturing insect (nymph) looks somewhat like the adult all through its development. The nymph is equipped with wing buds which will not fully develop into functional wings until the final molting stage. The mouthparts, legs and antennae are basically the same as the adults. Some nymphs live in water and breathe by gills until they mature. Examples of insects that develop by gradual metamorphosis are cockroaches, grasshoppers, crickets, stink bugs, lice and cicadas.

COMPLETE METAMORPHOSIS: Most of the insects mature by this last growth process. They do not make a gradual change from nymph to adult. The immature and mature forms differ so greatly that one would not believe them to be the same insect, and quite often they live in very different habitats.

Their development proceeds through four stages. A *larva* hatches from the *egg*. In this stage, the insects are referred to as caterpillars, grubs or maggots, and it is at this time that many insects do their greatest damage. The larva shows continued growth and molting and may proceed through several instars. The larva may or may not have legs, and the head may lack development. If the adult is to be winged, the wings will begin to develop internally. At the end of the larval stage, the organism slows its activity and forms a smooth, hard, protective, outer covering and enters into the *pupal* stage. The insect does not feed during this period and is usually inactive. The final molt occurs at the end of the pupal stage, and the *adult* form emerges. Shortly thereafter, colors develop, and the wings expand and harden. Many familiar insects follow this pattern such as maggots to flies, grubs to beetles and caterpillars to moths and butterflies. Other common groups with complete metamorphosis are fleas, wasps, hornets and bees.

Other arthropods can be pests too, such as mites, ticks, spiders, millipedes and scorpions. These insect relatives molt and have other characteristics like insects but none have a pupal stage, nor do any have wings.

WEEDS

When plants grow in undesirable areas, they are referred to as weeds. Common crop plants are considered weeds if they grow and compete in a field that has been seeded for a different crop. Weeds can reduce crop yields, increase production costs and reduce the quality of crop and livestock products. Some are poisonous or cause skin irritation while others are undesirable simply because they reduce the aesthetic value of landscaped areas. The many different weeds fall into four categories according to their life cycles.

SUMMER ANNUALS

Plants of this type have a one-year life cycle and result from seeds that sprout in the spring or summer. These plants mature, produce seed for the next generation and die in one growing season. The seed produced will lie dormant and then germinate during the following spring. Seeds not germinating at this point may do so at a later time when conditions are again favorable. Crabgrass, foxtail and pigweed are summer annuals.

WINTER ANNUALS

Members of this group have a one-year life cycle and grow from seeds that sprout in the fall. They mature, produce seed and die before summer. Their initial growth in early winter may be inconspicuous, but the growth rate increases toward the end of winter, and flowers and seed are produced. The seeds of most winter annuals are dormant during the spring and summer but germinate with the arrival of fall. Some species, whose life cycles are timed with fall-sown grains, produce mature seeds at the time the grain is harvested. The weed seed mixes with the grain, creating problems in marketing. Some representative winter annuals are henbit, field pepperweed, annual bluegrass and chickweed.

BIENNIALS

Biennials have a two-year cycle. When grown from seed, they develop a heavy root and a compact cluster of leaves close to the ground in the first growing season. During the following growing season, they mature, flower, produce seed and die. There are only a few species of biennial weeds, but they may appear anytime during the growing season. Bull thistle is one common biennial.

PERENNIALS

Plants which live more than two years or indefinitely are called perennials. They can grow from seed or from vegetative parts such as tubers, bulbs, rhizomes (root-like stems) or stolons (modified above-ground stems that bend down and take root). Their encroachment into new areas does not completely depend on seed production. Rhizome and stolon pieces can be transported in soil or by equipment. Seed dispersal is the major method of introduction into new areas, and once established, they rapidly spread, often forming patches. Quackgrass, dandelions, plantains and Johnsongrass are examples of perennial weeds.

DISEASES

Any condition that impairs the normal development or execution of normal life functions of a plant or animal is referred to as a disease. These situations are most often brought about by the presence of bacterial, viral, protozoan or fungal pathogens and parasites. Each year, tremendous economic losses can be attributed directly or indirectly to diseases of domestic animals, poultry and crops. Animal diseases reduce production rates and meat value, and some of these infections take on greater importance due to the fact that they can spread to man. Ornamental and crop plants alike are the targets of plant diseases which lower quality and yields. Severe cases of some of these plant diseases can result in complete crop failure.

FUNGI

The fungi are lower forms of plant life and are a very diverse group. They are familiar to us in everyday life as mushrooms, toadstools, molds, mildews, rusts, rots and smuts. They grow and thrive on almost any substance, including such things as water, food, leather, fabric, fibers, paper, glass, plants and animals. Ringworm, athlete's foot and histoplasmosis are just some of the fungal diseases that directly affect man.

Fungi are beneficial in many ways. Their ability to decay plant and animal materials makes them very valuable for maintaining soil fertility. Fungi are used in the manufacture of organic acids, and drugs and in the food industry to produce cheese. Also, some yeasts are used in brewing and baking processes.

Fungi are a lower plant form and lack chlorophyll, the green substance used by higher plants to manufacture their own food. They must live and grow on dead organic matter as saprophytes or on living organisms as parasites. The fungus may kill the host or live and obtain nutrients without causing death.

Of all the parasitic diseases of plants, those caused by fungi are, by far, the most frequently encountered. Almost every plant is subject to infection by at least one type of fungi. In severe cases, quickly spreading diseases can result in crop failure. The devastating Irish potato famine which began in 1845 and the mildew diseases that destroyed the French wine industry from the 1870s to 1880s are examples of the effects of these diseases in agriculture. Not all parasitic fungi have such devastating effects but a variety of them still present a real problem in agriculture and its related activities. A few of the fungal plant diseases that frequently must be dealt with are wheat rusts, potato blights, tomato blights, powdery mildews of rose, lilac, chrysanthemum and other ornamentals, Dutch elm disease, and chestnut blight.

The development of most fungal growths consists of structures which are vegetative or reproductive. In the vegetative stage, the fungus grows on or through the substratum, (the material on which the fungus lives), obtaining nutrient materials by secreting enzymes to break down the cell walls. This vegetative growth may be a single cell or many cells in long thread-like filaments (hyphae). In many cases these hyphae are very difficult to see. As they grow and interlace, they stretch out and attach themselves to new substrate material.

In the reproductive stage, the fungus has the ability to reproduce itself by spores or other means. Compared to vegetative structures, the reproductive structures are much more visible. They develop from the vegetative structures and they differ greatly in form, depending on the genus and species. The common "mushroom" is nothing more than the reproductive portion of a fungus.

Spore formation is the most common method of reproduction in fungi. These are small one-cell units that germinate and form a new plant and are produced in several ways. Millions of spores can be produced by a single fungus and because of this, the surrounding air is more or less filled with spores. These spores can then be disseminated by air currents, splashing rain, insects or other factors. These spores may even be dormant in the soil during periods of unfavorable weather and germinate at a later time.

The factors that play a role in the seriousness of any fungal infection are the number of infecting spores, temperature, humidity, cultural practices, soil moisture and control methods.

BACTERIA

Bacteria are microscopic, single-celled organisms which are so small that many thousands can fit into a drop of water. They can be found everywhere--in air, soil, fresh and salt water, and on plants and animals. Many bacteria benefit man's interests. Some of these organisms decay materials in the soil, making it fertile, while others produce nitrogen in a form useful to plants. Bacteria have been classified and divided into three common forms: rod shaped, oval or sphere shaped and spiral configuration. Most require air for their continued growth but there are some that prefer to exist in the complete absence of oxygen.

Except for a small number that can produce their own carbohydrate food, bacteria survive by obtaining nourishment from the organic materials of plants and animals. Of these, most will grow on decaying plant and animal material while some exist as parasites which attack the living cells of plants and animals.

In a favorable environment, bacterial organisms reproduce themselves readily by the process of cell division. This is achieved by the formation of a crosswall in the cell and two daughter cells result. As this process continues, filaments or colonies are formed. These cells can resist dry conditions and temperature extremes, and some form spores inside when conditions become too unfavorable. Long after the cell is destroyed and more favorable conditions exist, these spores can develop.

Bacteria surround us and when the parasitic forms come in contact with a plant or animal under the right conditions, an infection or disease may result. Ingestion, inhalation or exposure of open wounds are just a few of the ways in which they can attack an animal.

Bacterial plant pathogens can be spread in a number of ways—by wind, water and soil movements, cultural practices, insects or animals. An insect carrying bacteria may feed on a plant and thereby infect the plant. Some bacteria may enter through the water pores and air openings of the plant or simply through wounds. Some may attack the root system also.

Livestock are targets of bacterial diseases such as anthrax, blackleg, brucellosis and mastitis and fowl cholera infects poultry.

The parasitic (pathogenic) bacteria are the causal organism for a wide variety of plant diseases including many spot diseases, wilts, rots, galls and blights. Fire blight and crown gall of fruit trees, wildfire of tobacco, leaf spot of carnations, black twig blight of lilacs, bacteria blight and bacterial wilt of soybeans, fire blight of apples and pears and bacterial wilt of sweet corn are just a few of the plant pathogens.

It is important to remember that some of these destructive diseases are difficult to identify and the symptoms of vastly differing diseases may be similar. After careful study, if a question remains, the advice of an expert might be warranted.

VIRUSES

Viruses are extremely small disease-causing organisms, so small that one must use an electron microscope just to see them. Because of size, their presence is detected only by the symptoms they produce. A particular virus is usually very specific in the type of host in which it infects and multiplies. Also, it will limit itself to one type of tissue. Since the response in the host is usually so specific, viruses are named for the type of disease they produce (hog cholera — hog cholera virus). Viruses are capable of

attacking anything from bacteria to plants and animals. As a cause of much human suffering and considerable losses to the agricultural economy, these pathogens are undergoing intense investigation by scientists.

In crop economic losses, they stand only second to the fungi in importance. Cucumbers, tobacco, sugar beets, corn, fruits, potatoes, asters, elm and beans are just a few of the plants subject to virus infection.

Animal disorders such as foot-and-mouth disease of cattle, hog cholera, Newcastle disease of chickens and rabies and distemper of dogs are all virus caused infections.

Viruses reside in living hosts as opposed to some of the bacteria and fungi that live and grow on decaying material. They must have a living host in order to reproduce themselves and manage to take over control of a host cell and direct it to produce material to make new viral particles. The virus cannot make this material itself. In the process the host cell is destroyed.

Plant viruses are divided into two groups according to the kind of injury they produce. One group, the Mosaics, produce a mottling or a characteristic ring spotting of the leaves. Yellowish spots and blotches make up the disease areas. The second viral type are the yellows, causing dwarfing, leaf curl and yellowing. Mosaics and yellows are responsible for great economic loss in crops, the former taking the greater toll.

Pathogenic plant viruses are spread by a variety of methods. Propagation techniques involving infected seeds, bulbs, roots, tubers or cuttings can allow virus diseases to take hold. Transmission can also occur through the use of contaminated equipment to handle healthy plants. Insects that feed upon plants such as aphids, mealybugs and leafhoppers, can carry the virus from plant to plant while they feed. Pollen, nematodes and fungi can also serve as vectors for virus.

NEMATODES

Nematodes (nemas) are roundworms of various sizes, some being parasitic for man and other animals, while others live on decaying material. The plant nematodes are very small, often microscopic, and are many times referred to as eelworms. Their life cycle includes an egg, four larval stages and an adult. Plant pathogenic nematodes live in soil and for the most part attack roots and other underground plant parts although above ground parts (leaves, stems, seeds) may be the target. As they feed their bodies become enlarged and rounded and swelling may occur in the attacked plant tissues.

Nemas may enter through air openings, water pores or by the wounds that result from mechanical injury. They may merely puncture the surface or enter completely and although the plant may not die, it is left in a weakened condition. As cells are destroyed or damaged, the plant is then left vulnerable to secondary infections by bacteria, fungi or viruses. Organisms of this type are responsible for economic losses in field crops (corn, alfalfa, soybeans, tobacco, etc.), vegetable crops (tomatoes, carrots, etc.), ornamentals and many turf varieties.

PLANT DISEASES

A plant disease may be described as any condition that interrupts the normal development of a plant by altering the appearance or function. Disease conditions may adversely affect the growth habit (stem, branches, roots), leaf shape and size, flowering and fruiting characteristics and all internal plant processes.

The causes of plant disease can be separated into two basic groups, the parasitic and the nonparasitic forms. The nonparasitic ones are classified together because they are all brought about by some unfavorable growth condition for the plant. Typical of the undesirable conditions are deficiencies or excesses in water or nutrient material, improper light, temperature extremes, mechanical injury and undesirable chemicals in the air and soil. Included in the parasitic group are those diseases caused by bacteria, fungi, nematodes (nemas) and viruses.

These parasitic organisms can be found on the interior or exterior of the plant, and the severity of infection will depend on the virulence of the disease and the plant's resistance. In most cases certain temperature and moisture conditions are required for infection, so therefore, climate plays an important role. Some disease organisms flourish only during rainy periods just as others cannot survive the extremes of cold.

Disease organisms must be able to overwinter in order to be able to infect plants during more favorable conditions. To do this, they may form resistant spores, or they may overwinter inside the host plant. Some may find protection in the seeds of plants while others may survive the winter in the tissues of an insect vector. Whatever the system, the life cycles of these parasitic organisms are all different and may vary from the extremely simple to the very complex.

Parasitic plant diseases are given a general classification by the types of visible symptoms they produce. They can be referred to as leaf spots, wilts, smuts, cankers, blights, blotches, rots and mildews.

SPOT DISEASES:

The spot diseases are recognized as a mark or blotch of discoloration found on the foliage or stem of the infected plant. They can be caused by numerous types of fungi and the accompanying environmental conditions. Each spot disease has a characteristic color and many are arranged in concentric rings. Each has a typical size and shape and in some cases, the disease affected area may also fall out forming a hole in the leaf. Certain insects may cause spotting of leaves.

WILT DISEASES:

Wilt conditions can be caused by a number of agents. Wilting may be due to a water deficiency or because of pathogens such as bacteria and fungi. In most cases, there has been a blockage of the water conducting system of the plant due to disease or mechanical injury.

DAMPING-OFF:

Any of several fungi can cause this rotting of seedlings and cuttings. Seedlings may be attacked after germination but before they break through the soil. Postemergence attack can also occur, resulting in the killing of roots and stems at the soil surface. As cells are destroyed the plant weakens and falls over.

SMUTS:

These diseases are called smuts because of the sooty-black masses of spores that they produce. The target of the infections are usually the heads of corn and other cereal crops. The cause of the diseases are the true smuts fungi of the order Ustilaginales. The powdery masses break into dust-like powder when disturbed and the spores are then dispersed by the wind. Many of the fungi enter the host plant at an early stage of the plant's development and grow with it until the plant reaches maturity.

RUSTS:

Although this name is commonly applied to many ailments resulting in reddish-brown spotting or color change in plants, it is most accurately used to describe infections caused by fungi of the family Uredinales. They must reside on living plants and grow internally. The fungus penetrates cells and then removes the cell's nourishment.

ROTS:

Any large-scale decay of living plant material by an organism may cause rot. The name "rot" is used to describe many conditions which are caused by bacterial or fungal infestations.

BLIGHTS:

This is a commonly used term describing diseases occurring because of attacks of bacterial, fungal or viral parasites. Undesirable climatic conditions are also a contributing factor. The target area is usually the young growth of a plant, and the end result is withering and general death of stems, leaves and flowers.

BLOTCHES:

General terminology such as this is used to describe diseases that arise from any of a number of plant pathogens. Usually, it is referring to the appearance of the diseased area. A plant with a blotch disease has infected areas that are irregular in size and shape, which separates them from the spot diseases.

CANKERS:

An area of diseased woody tissue is often described in this way. Infestation by any parasite or damage by other factors results in the shrinking and cracking of tissues, leaving an open wound.

MILDEW DISEASES:

Plant pathogens of this type are evidenced by fungal growth that form on the surface areas of a plant, such as the leaves and stems. It may appear white, gray, downy or powdery, giving rise to such names as "downy mildew" or "powdery mildew". The severity of tissue infection is dependent upon the type of fungal organism.

MOSAIC DISEASES:

Many virus diseases are given this name because of the mosaic-like appearance of diseased leaves of the host plant. The leaves are mottled with light and dark areas and may show wilting and curling.

PEST CONTROLS

Man can encounter a wide variety of pest problems associated with his daily activities and interests. Whether they be diseases or unwanted plants and animals, the success of the control measures will depend on the use of a logical approach to the problem. The pest must first be identified. Knowing the characteristics of the pest organism and the crop or animal being threatened results in the choice of good control and management practices. The available control methods, including their risks and benefits, must be considered. The methods must be chosen that will be most effective and cause the least harm to the environment.

With most pest problems a condition arises, symptoms are analyzed, and then some type of corrective action is taken. However, not all pest problems can be attacked by this method. The approach to plant disease problems is one that differs in that the control is based primarily on prevention of the disease condition. In many cases, once the plant disease is recognized, it is too late for proper treatment.

There are control procedures available for treating pest problems and the degree of effectiveness depends on the type of problem and the severity. The following are the most important control methods.

NATURAL CONTROLS

A natural control is any ordinary condition in nature that slows down the reproduction and growth rates of pest species. Weather factors, such as moisture and temperature, are major control forces of insect and plant disease problems. Predatory and parasitic insects and some birds destroy many insect pests. Virus, fungus and bacteria diseases also take their toll among insects.

BIOLOGICAL CONTROLS

Biological controls involve man's use of natural predators, parasites, diseases and breeding techniques to reduce the numbers and economic impact of pest species. By releasing natural enemies, man can help control the pest. Aphid-parasitizing insects, one fungus antagonistic to another, and nematode-trapping fungi are all examples of biological controls.

Varieties of plants, which strongly resist disease and insect pests, have also been developed by man.

Another technique being used is the release of sterile male insects, causing interference in normal insect reproductive behavior.

PHYSICAL AND MECHANICAL CONTROLS

Physical controls are sometimes the most effective measures and include anything from fly swatters to ultra-high frequency sound production for killing pests. The use of radiation, distress and mating calls, repellents such as reflective "mulches", steam soil sterilization, and the various light, bait and sticky traps are all physical control methods. Other methods are electric shock grids, barriers, filters and fences for pest control. Habitat manipulation may involve flooding, drainage and nesting site destruction. Basic control measures for weeds are cultivation and the cutting of top growth to reduce weed vigor.

CULTURAL CONTROLS

Planting, growing, harvesting and tilling practices are all part of the cultural control of pests. Additional cultural control practices are crop rotation, construction methods, timing of planting and proper fertilization. With a knowledge of the pest, one can combine cultural controls with physical and mechanical practices to disrupt the normal association between a pest and its host.

Crop rotation can prevent the buildup of a pest population that favors one kind of plant. Some plant pathogens are unable to survive when a certain host is not present. Planting an alternative crop on which the parasite cannot exist will reduce parasite numbers after a time. The vulnerable crop can then be grown again.

Proper cultural practices, such as correct fertilization, will prevent certain diseases by producing vigorous plants. The removal of diseased plants and plant parts is very helpful in controlling diseases. Planting, tilling and cutting sequences are also a factor. The planting of crops in early spring before germination of weed seed will help avoid summer-annual weed problems. Insect pests can sometimes be controlled by carefully timed plowing which destroys a certain insect life stage.

CHEMICAL CONTROLS

Chemicals are used in a number of ways to control pest populations. They may be used to kill pests or they may act indirectly in the control method as repellents, attractants, sex stimulants, hormones or plant-growth regulators. The primary advantage of chemicals is speed in controlling pest problems, but in many cases their value is in protecting the host from possible disease infestations.

Pesticides and their related products come in many formulations. Most common are the emulsifiable concentrates, wettable powders, granules, aerosols (smokes, fogs, steam, vapors, etc.) baits (lures), dusts and impregnated materials.

Chemical control materials can be absorbed by pests in many ways. With contact absorption, the pest organism is adversely affected when it touches the pesticide. Plants can absorb herbicides through foliar (leaf) or root absorption. In the case of animal pests, some chemicals must be ingested before they take effect.

Some pesticides are referred to as systemics because they must be taken up and retained by the host. They render the potential plant or animal host toxic to pests feeding on it. The systemic may inactivate disease-produced toxins or directly attack the pest organism.

Certain chemicals act as pest repellents while others act as inhibitors of normal plant activity. Some weeds are controlled by photosynthetic-inhibiting herbicides which reduce weed vigor. Preemergence herbicides kill weed seedlings before or soon after they break the surface.

Other materials are referred to as chemical attractants and are used to lure insect pests to areas where they can be killed. These "pheromones" can be of an assembly-aggregation type or a sex attractant-sex stimulant type.

INTEGRATED CONTROLS

Often a combination of control methods is needed to achieve the desired effect. Combinations of bio-cultural controls, bio-physical controls and cultural-physical controls are very common.

When pests threaten, there are three basic approaches available to meet the problem.

PREVENTION: Steps can be taken to avoid infestations. Inspections and quarantines will help keep pests from infesting new areas. Clean conditions, cultural controls, treated seed, resistant varieties and pesticides all help to prevent problems.

SUPPRESSION: Once pest infestations have occurred, steps must be taken to reduce their numbers to acceptable levels. Chemical, cultural, physical and biological controls all help reduce the pest populations to keep damage to a minimum.

ERADICATION: In some cases, it is necessary to press control procedures even further to include the complete destruction of a pest in an animal or a crop area. Removal or destruction of diseased parts, or sterilization and fumigation of soil are examples of this total approach.

PLANT - DISEASE INDEX

ASPARAGUS *(Asparagus officinalis)*
- Rust

BEANS
- Green *(Phaseolus vulgaris)* and
- Lima *(Phaseolus limensis)*
  - Anthracnose
  - Bacterial blights
  - Damping-off
  - Downy mildew of lima beans
  - Fusarium dry root rot
  - Pod blight of lima beans
  - Powder mildew
  - Pythium root rot and wilt
  - Rhizoctonia root rot
  - Rust
  - Seed rot
  - Stem anthracnose
  - Viruses
  - White mold

CRUCIFERS
- Cabbage *(Brassica oleracea* var. *capitata)* and
- Broccoli *(Brassica oleracea* var. *italica)*
  - Alternaria leaf spot
  - Black leg
  - Black rot
  - Club root
  - Damping-off
  - Downy mildew
  - Edema

CUCURBITS
- Cucumber *(Cucumis sativus)*,
- Cantaloupe *(Cucumis melo)*,
- Squash *(Cucurbita maxima)*,
- Watermelon *(Citrullus vulgaris)* and
- Pumpkin *(Cucurbita pepo)*
  - Alternaria
  - Angular leaf spot of cucumber
  - Anthracnose
  - Bacterial wilt
  - Downy mildew
  - Fusarium wilt of cantaloupe
  - Fusarium wilt of watermelon
  - Gummy stem blight
  - Mosaic viruses
  - Powdery mildew
  - Root knot
  - Scab

PEA *(Pisum sativum)*
- Pea root rots
- Pea viruses

PEPPER *(Capsicum frutescens)*
- Anthracnose
- Bacterial leaf spot
- Pepper viruses

SWEET CORN *(Zea mays)*
- Bacterial wilt
- Northern leaf blight
- Southern leaf blight
- Smut

SWEET POTATO *(Ipomoea batatas)*
- Fusarium wilt
- Pox
- Scurf

TOMATO *(Lycopersicon esculentum)*
- Anthracnose
- Blossom-end rot
- Buckeye rot
- Early blight
- Fusarium wilt
- Late blight
- Leaf roll
- Root knot
- Viruses

WHITE POTATO *(Solanum tuberosum)*
- Common scab
- Early blight
- Late blight
- White potato viruses

DISEASE	DESCRIPTION AND DAMAGE	CONTROL AND MANAGEMENT PRACTICES
ALTERNARIA LEAF BLIGHT *(Alternaria cucumerina)*	Cucurbits Fungus overwinters in the soil on diseased crop refuse and is also carried on and in the seed. Small circular spots appear first on the older leaves. These spots enlarge with definite concentric rings and margins in the upper surface of the leaves. Plants are rapidly defoliated.	Practice crop rotation. Use disease-free seed. Use resistant varieties. Apply protective fungicidal sprays. For recommended fungicides, see Extension Bulletin 236.
ALTERNARIA LEAF SPOT *(Alternaria brassicae)*	Crucifers Fungus overwinters in the seed and refuse from diseased plants. Leaf spots appear as brown to black concentric circles. Spots first occur on the lower (older) leaves.	Use disease-free seed. Employ long rotations.
ANGULAR LEAF SPOT *(Pseudomonas lachrymans)*	Cucumbers Bacterium overwinters in diseased plant refuse and on the seed. Spots on the leaves are angular and irregular in shape and size. These watersoaked areas turn gray, die and drop out leaving irregular holes in the affected leaves.	Practice a 1-to 2-year crop rotation. Use disease-free seed. Bactericidal sprays are helpful. For recommended bactericides, see Extension Bulletin 236.

DISEASE	DESCRIPTION AND DAMAGE	CONTROL AND MANAGEMENT PRACTICES
ANTHRACNOSE *(Colletotrichum lindemuthianum)*	Beans Fungus overwinters in bean seed and in field refuse from diseased plants. The most characteristic symptoms of this disease are the sunken cankers or lesions on the pods, which may be about ½ inch in diameter with salmon-colored ooze in the center.	Use western-grown, healthy seed. Plow under diseased bean refuse and practice 3-year or longer rotation.
(Colletotrichum lagenarium)	Cucurbits Fungus overwinters in old, diseased refuse in the soil as well as on and in the seed. Spots on foliage begin as small yellowish or water-soaked areas that enlarge rapidly and turn brown in most cucurbits but black in watermelon. Elongated lesions, similar to those on the leaves, are present on the stems. On the fruit, circular, black, sunken cankers are formed.	Practice crop rotation. Use disease-free seed, resistant varieties and protective fungicidal sprays. For recommended fungicides, see Extension Bulletin 236.
(Colletotrichum piperatum)	Pepper Fungus may overwinter in the soil in diseased refuse and on and in the seed. Depressed lesions, varying in size, covering much of fruit surface when they coalesce.	Rotate with crops not belonging to the solanaceous family. Use disease-free seed and protective fungicidal sprays. For recommended fungicides see Extension Bulletin 236.
(Colletotrichum phomoides)	Tomato Fungus overwinters in the soil, in old diseased vines and on and in the seed. Green fruit become infected but lesions do not develop until ripening begins. On ripe fruit, small, circular, slightly-sunken spots appear which increase in size and develop dark centers.	Long rotation. Use disease-free seed and apply protective fungicidal sprays. For recommended fungicides, see Extension Bulletin 236.

DISEASE	DESCRIPTION AND DAMAGE	CONTROL AND MANAGEMENT PRACTICES
BACTERIAL BLIGHTS	Beans Several different species of bacteria overwinter in the seed and in refuse from diseased plants left in fields. Common bacterial blight is characterized by large brown spots on leaves and watersoaked spots with red margins on pods. Halo bacterial blight is characterized by numerous brown leaf spots with yellow halos. Watersoaked spots also occur on the pods.	Use western-grown healthy seed. Practice crop rotation and plow under all bean refuse. Spread of small infections may be reduced with copper sprays.
BACTERIAL LEAF SPOT *(Xanthomonas vesicatoria)*	Pepper Bacterium may overwinter in the soil, in diseased refuse and on and in the seed. Small, dark-brown spots occur on leaves. Leaves turn yellow and drop. Spots on the fruit are blister-like, becoming rough and cankerous.	Use crop rotation for at least 3 years. Use disease-free seed to produce healthy transplants. Maintain high level of fertility to stimulate additional leaf formation to replace those lost from infection. Use bactericidal sprays. For recommended bactericides, see Extension Bulletin 236.
BACTERIAL WILT *(Erwinia tracheiphila)*	Cucurbits Bacterium overwinters in the bodies of the striped and 12-spotted cucumber beetles. Initially, several leaves droop or the leaves on one runner wilt. This is followed by the entire wilting and death of plant.	Early control of cucumber beetles with insecticide. For recommended insecticides, see Extension Bulletin 236.
BACTERIAL WILT *(Bacterium stewartii)*	Sweet corn Bacterium overwinters in the corn flea beetle and is spread to corn when the beetles feed on corn plants. More severe on young plants than on older plants. Pale-green to yellow streaks on leaves which later turn brown. Early-infected plants may die; late-infected plants may be stunted or merely have streaked leaves.	Early control of flea beetles. Use resistant varieties.

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DISEASE	DESCRIPTION AND DAMAGE	CONTROL AND MANAGEMENT PRACTICES
BLACK LEG *(Phoma lingam)*	Crucifers Fungus which may live for 3 years in the soil and can be carried upon and within the seed. First symptom is a sunken area on the stem near the ground line. Area increases in size until entire stem is girdled. Small black dots develop within this area. Similar lesions occur on the leaves.	Rotate for at least 4 years. Use disease-free seed.
BLACK ROT *(Xanthomonas campestris)*	Crucifers Bacterium can overwinter in diseased refuse and be carried upon and within seed. Affected seedlings turn yellow and die. On older plants, yellow, wedge-shaped areas appear at leaf margins. Heads are dwarfed and soft rot soon develops.	Rotate for at least 2 years. Use disease-free seed (hot water treated seed).
BLOSSOM-END ROT	Tomato The rot is caused by a calcium deficiency in the fruit. The rot is characterized by a large, dry, brown to black, depressed leathery area at the blossom end of the fruit.	Do not allow plants to undergo moisture stress. Too little or too much water can limit calcium uptake. Try to govern soil moisture. Plant in well-drained areas with proper aeration. Avoid excessive use of nitrogen fertilizers. Do shallow cultivation to avoid root pruning, especially during dry weather.
BUCKEYE ROT *(Phytophthora parasitica)*	Tomato Fungus can persist in the soil for an indefinite period of time. Disease appears as brownish spot often at contact point between fruit and soil. Spot enlarges and commonly assumes a pattern of concentric rings of narrow, dark-brown and wide, light-brown bands. Disease development is very rapid under heavy moisture conditions in poorly drained areas of the field. The foliage is not affected.	Avoid poorly drained areas in the field. Practice crop rotation. Protective fungicidal spray may be helpful. For recommended fungicides, see Extension Bulletin 236.

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DISEASE	DESCRIPTION AND DAMAGE	CONTROL AND MANAGEMENT PRACTICES
CLUB ROOT *(Plasmodiophora brassicae)*	Crucifers Fungus can persist in the soil for at least 7 years. Wilting and yellowing of above ground parts of the plants. Roots of these plants are much enlarged and malformed.	Long crop rotation. Use resistant varieties and healthy transplants. Disease is not a problem in soils with pH 7.2 or greater. Use of fungicide in the transplanting water. For recommended fungicide, see Extension Bulletin 236.
COMMON SCAB *(Streptomyces scabies)*	White potato Fungus can remain indefinitely in favorable soil. Distributed chiefly on infected seed tubers and in wind and water-borne soil. Superficial roughened areas first appear on the surface of the tubers. These areas become corky, rough, and pitted and scabby in appearance.	Use healthy disease-free seed. Use disease resistant varieties. Disease organism is generally not active in soils with low pH (5.2 pH or lower).
DAMPING-OFF and SEED ROT	Beans Caused by numerous soil fungi which are common in many soils and are active during cool wet periods. Seeds are more susceptible to infection and decay under conditions which exhibit rapid germination and growth. Infection results in poor germination, seed decay, rotting of stem at soil surface, death of growing seedlings and severe reduction in stand of plants.	If possible, plant seed under conditions favorable for germination and rapid growth. Use seed treatment (protective coating of fungicide on surface of seed).
DAMPING-OFF and WIRE STEM *(Rhizoctonia solani)*	Crucifers Primary cause is the fungus which persists in the soil for long periods of time. Tissue of seedlings becomes water-soaked at soil line. Young seedlings topple over and die. Wire stem is characterized by stems that are darkened and girdled near the soil line. Affected plants are weak and may wilt and die.	Long rotation of seed bed. Treatment of soil in seedbed with fungicide. For recommended fungicides, see Extension Bulletin 236.

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DISEASE	DESCRIPTION AND DAMAGE	CONTROL AND MANAGEMENT PRACTICES
DOWNY MILDEW *(Phytophthora phaseoli)*	Lima beans Fungus overwinters in diseased seed and in refuse from diseased plants. White downy mold appears on the pods which shrivel, die and turn black.	Use resistant varieties; long rotation. Use protective fungicidal sprays. For recommended fungicides, see Extension Bulletin 236.
(Peronospora parasitica)	Crucifers Fungus overwinters in roots or old diseased plants. Small, yellow leaf spots appear on young leaves. On older leaves, the yellow spots enlarge with fluffy downy growth on the underside.	Use disease-free seed, rotations and destruction of mustard weeds near plant beds. Protective fungicidal sprays will control this disease. For recommended fungicides, see Extension Bulletin 236.
(Pseudoperonospora cubensis)	Cucurbits Fungus overwinters in the far South and is blown northward as the warm season advances. Irregularly-shaped, yellowish to brown spots appear on the upper sides of the older leaves. Under moist conditions, purplish mildew growth develops on the undersides of the leaf spots.	Use resistant varieties. Use protective fungicidal sprays. For recommended fungicides, see Extension Bulletin 236.
EARLY BLIGHT *(Alternaria solani)*	Tomato Fungus can survive in the soil at least 1 year in old diseased vines. The pathogen can also be carried in the seed. Leaf spots initially appear on the older leaves. These spots are circular, brown, concentrically ringed spots that appear singly or in large numbers on each leaf, quickly turning the foliage yellow to brown. This results in severe defoliation of the plant.	Long rotation. Use disease-free seed to produce healthy transplants. Apply protective fungicidal sprays. For recommended fungicides, see Extension Bulletin 236.

DISEASE	DESCRIPTION AND DAMAGE	CONTROL AND MANAGEMENT PRACTICES
EARLY BLIGHT *(Alternaria solani)*	White potato Fungus can overwinter in the soil on old diseased plant refuse. Appears first as spots on the leaflets. These oval spots are dark brown to black with concentric ridges which produce a characteristic target-board effect. Lowest leaves are affected first, drying up and drooping as the disease progresses upward. Plant may be severely defoliated.	Crop rotation. Use protective fungicidal sprays. For recommended fungicides, see Extension Bulletin 236.
EDEMA	Crucifers Small wart-like prominences generally on the undersides of leaves. A nonparasitic disease which is caused when the soil is wet and at a high temperature and then a sudden drop in air temperature occurs. For example, a cool night following several warm muggy days.	When irrigating, avoid allowing the soil and air to remain excessively wet.
FUSARIUM DRY ROOT ROT *(Fusarium solani f. phaseoli)*	Beans Fungus lives in bean refuse and also in soil for many years. Appears soon after seedlings emerge. Taproot takes on a bright red color and finally becomes brown with longitudinal cracks. Lateral roots are killed and end of taproot shrivels. New fibrous roots may form just above discolored area and just below soil surface.	Long rotation, 6 years or longer. Plant on well-drained, well-fertilized soil which will give good vine growth. Avoid close cultivation.
FUSARIUM WILT *(Fusarium oxyporum f. melonis)*	Cantaloupe Fungus persists in the soil for a long period of time and may also be seed borne. Characterized by a stunting, yellowing and wilting of the vines. A streak, at first water-soaked, later turning yellow to tan and finally dark brown, often appears at the soil line on one side of the vine. Often the vine cracks open and sap oozes out and collects in amber drops.	Use resistant varieties and disease-free seed.

DISEASE	DESCRIPTION AND DAMAGE	CONTROL AND MANAGEMENT PRACTICES
(Fusarium oxysporum f. niveum)	Watermelon Fungus persists in the soil for an indefinite period of time. Plants are affected at all stages of growth. Leaves lose their green color, drop and wither. In older plants the vines wilt, then shrivel and die. The inner part of the main root becomes yellow or brown. In wet weather, dead stems have a white or pinkish fungus growth on their surface.	Use resistant varieties. Long crop rotation.
(Fusarium oxysporum f. batatas)	Sweet potato Fungus lives in the soil for indefinite period of time. Leaves turn light green to yellow and the vines soon wilt and then the entire plant dies.	Long rotation. Use healthy seed for sprout production. Use resistant varieties.
(Fusarium oxysporum f. lycopersici)	Tomato Fungus can persist in the soil for indefinite period of time. Wilting of plant occurs with yellowing of foliage from base of plant upward. At times, one-sided wilting may occur on plants or leaves. Cutting of stem at soil line reveals a brown ring which extends upward in upper parts of the plant. Generally, plant is killed at time of fruiting.	Use resistant varieties.
FUSARIUM YELLOWS *(Fusarium oxysporum f. conglutinans)*	Crucifers Fungus can persist in the soil for many years. Plants have a sickly, yellow, dwarfed appearance. At times, the yellowing may be more intense on one side of the plant.	Use disease-resistant varieties.
GUMMY STEM BLIGHT *(Mycosphaerella melonis)*	Cucurbits Fungus overwinters in diseased plant refuse and in or on the seed. Spots on leaves, petioles and stems are generally pale brown to gray. Those on stems elongate into streaks and may have an amber exudate of gummy material. Tiny, black, pimple-like structures develop on fruit, stem and leaf spots.	Long rotation with crops other than cucurbits. Use disease-free seed and protective fungicidal sprays. For recommended fungicides, see Extension Bulletin 236.

DISEASE	DESCRIPTION AND DAMAGE	CONTROL AND MANAGEMENT PRACTICES
LATE BLIGHT *(Phytophthora infestans)*	Tomato Fungus overwinters in the South and can move northward by strong winds during the growing season. Prolonged periods of cool rainy weather are necessary for disease development. The fungus attacks any part of the tomato plant above ground. Initially, water-soaked areas appear on the leaves. These leaf lesions dry out and become brown and shrivel. Olivaceous, greasy-appearing spots which may enlarge and involve whole fruit are formed on tomato. Fruit tissue may be firm at first but soon entire fruit rots.	Use disease-free transplants. Apply protective fungicidal sprays. For recommended fungicides, see Extension Bulletin 236.
(Phytophthora infestans)	White potato Fungus overwinters in infected tubers. Can appear on tops of the plants at any time in a favorable environment (wet and cool). On leaflets, it forms as brownish to purplish-black lesions which enlarge rapidly. Potato tubers may be infected while in the hill, at harvest and sometimes in storage. First sign of disease on tuber is a brown discoloration of the skin followed by brownish dry rot which extends ½ inch below the surface.	Use resistant varieties and a protective fungicidal spray. For recommended fungicides, see Extension Bulletin 236.
LEAF ROLL	Tomato Not a pathogenic disease. Can be caused by too much or too little moisture or severe root pruning. Some tomato cultivars normally roll their leaves. Leaf roll causes an upward rolling or curling of leaves, especially the older leaves at the base of the plant.	No control necessary.

DISEASE	DESCRIPTION AND DAMAGE	CONTROL AND MANAGEMENT PRACTICES
MOSAIC VIRUSES	Cucurbits A number of different viruses overwinter in various weed hosts and are transmitted to cucurbit crops by different insect carriers. Some viruses are carried in the seed. Plants are stunted, new leaves are dwarfed, mottled and distorted. Fruits are discolored and often malformed.	Use disease-free seed. Avoid planting near susceptible neighboring crops. Eradicate all infected perennial weeds. Use resistant varieties when available.
NORTHERN LEAF BLIGHT *(Helminthosporium turcicum)*	Sweet corn Fungus overwinters in the soil in diseased plant refuse. Leaf spots begin on lower leaves and move upward as season progresses. These spots are nearly elliptical in shape, ranging from 1 to 5 inches in length. When spots are numerous, entire leaf dies.	Use resistant varieties.
PEA ROOT ROTS	Pea Caused by a number of soil fungi which can persist in the soil and in refuse from diseased plants. Excessive soil moisture and poor drainage favor these root-rotting fungi. Plants become yellow and stunted. There are conspicuously discolored and rotted areas on the main root and at the base of the stem.	Avoid poorly drained planting areas and use crop rotation techniques. Provide ample fertility to encourage vigorous growth.
PEA VIRUSES	Pea Diseases caused by several viruses which overwinter in some plants belonging to the pea family (clover, vetches, alfalfa). Aphids transmit the viruses from these plants to nearby pea plantings. Leaves become yellow or mottled and plant is stunted. Pods are distorted with poor pod set.	If possible, plant early so that plant will be almost grown before aphids have time to multiply. Plant peas at least 100 yards from other leguminous crops. Use available resistant varieties.

DISEASE	DESCRIPTION AND DAMAGE	CONTROL AND MANAGEMENT PRACTICES
PEPPER VIRUSES	Pepper A number of viruses which overwinter in perennial weed hosts and are transmitted to pepper fields by aphids. Leaves of the plant become mottled and wrinkled and whole plant is dwarfed. Fruit set is reduced; fruit that develop are small and distorted.	Maintain rigid aphid control program. Destroy perennial weed hosts adjacent to pepper plants. Utilize available resistant varieties.
POD BLIGHT *(Diaporthe phaseolorum)*	Lima beans Fungus overwinters in affected seed and in bean refuse left in the field. First appears on leaves as large brown irregular spots. Spots or lesions occur on the pods. Small black specks appear in concentric rings within leaf and pod spots.	Use healthy (disease-free) seed. Rotate planting area.
POWDERY MILDEW *(Erysiphe polygoni)*	Beans Fungus overwinters on living plants in the South. Faint, discolored leaf spots covered with grayish-white (talcum-like) powdery growth. Pods may also become infected.	Use resistant varieties. If possible, avoid late planting of beans. Chemical control may be helpful.
(Erysiphe cichoracearum)	Cucurbits Fungus may overwinter on perennial weed plants. The fungus also overwinters in the far South and is blown northward as cold weather recedes. Appears as a talcum-like growth on the plant surfaces, especially on the upper side of the leaves.	Use resistant varieties. Use protective fungicidal sprays. For recommended fungicides, see Extension Bulletin 236.
POX *(Stretomyces ipomoeae)*	Sweet potato Fungus is a persistent inhabitant in soil favorable to its development. Small, dark, dry spots form on the surface of the sweet potato. This affected area dries and falls out leaving a pit or pox mark.	Use long rotation and healthy, disease-free roots for bedding. Maintain soil pH below 5.5. Use available resistant or tolerant varieties.

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DISEASE	DESCRIPTION AND DAMAGE	CONTROL AND MANAGEMENT PRACTICES
PYTHIUM ROOT ROT and WILT	Beans The cause can be any of several species of the fungus *Pythium* which can persist in the soil for many years. Will appear on both young and older plants. Characterized by colorless to dark, wet rot near the soil line. On older plants, wet rot may occur near first node with subsequent wilting and blighting of foliage and death of entire plant. Infection severe during periods of high temperature and humidity.	Utilize well-drained soils for plantings.
RHIZOCTONIA ROOT ROT *(Rhizoctonia solani)*	Beans Fungus persists in the soil for a long period of time. Slightly sunken, reddish-brown, longitudinal stem cankers occur near the soil line. Entire stem may rot and death of seedlings will occur. When the inner stem tissue is infected it will become brick red.	Plant in well-drained, fertile soil. Avoid deep planting of seed. Utilize all measures which will encourage rapid seed germination and seedling growth such as, shallow planting, ample moisture and sufficient nutrients.
ROOT KNOT *(Meloidogyne* spp.)	Cucurbits Nematodes which can persist in the soil for an indefinite period of time in the presence of a suitable host. Affected plants are stunted, weak and lack vigor. The roots of these plants are elongated with round swellings (root knots) on both large and small roots.	Long rotation with nonsusceptible crops. Utilize certain nematocides for chemical control. For chemical control of nematodes, see Extension Bulletin 236.
	Tomato Caused by nematodes which can persist in the soil for an indefinite period of time. Tomatoes are very susceptible. Affected plants are stunted and may wilt in hot, dry weather. The roots of these plants contain round swellings (root knots) on both large and small roots.	Use long rotations with nonsusceptible crops. Use healthy transplants and certain nematocides for chemical control. For chemical control of nematodes, see Extension Bulletin 236.

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DISEASE	DESCRIPTION AND DAMAGE	CONTROL AND MANAGEMENT PRACTICES
RUST *(Puccinia asparagi)*	Asparagus Fungus which overwinters in the "black spore" stage on old stems in the soil. Rust appears as orange pustules on stems and foliage. These pustules turn black in late summer.	Use resistant varieties such as *Washington* varieties. Clean up and destroy all unused beds as well as volunteer or wild asparagus plants. Apply post harvest protective fungicidal sprays. For recommended fungicides, see Extension Bulletin 236.
(Uromyces phaseoli f. typica)	Beans Fungus overwinters in the soil on old, diseased, plant tissue. Infections generally occur during late summer. Numerous reddish, dusty spots appear on the leaves and pods.	Use a long rotation and resistant varieties. Use protective fungicidal spray. For recommended fungicides, see Extension Bulletin 236.
SCAB *(Cladosporium cucumerinum)*	Cucurbits Fungus overwinters in old plant refuse and on the seed. Corky spots develop on the green, immature fruit. Under moist conditions a dark, olive-green, velvety growth covers the spots. Small irregular spots occur on the leaves, and the whole leaf may become ragged in appearance.	Practice crop rotation. Use disease-free seed and resistant varieties. Use protective fungicidal sprays. For recommended fungicides, see Extension Bulletin 236.
SCURF *(Monilochaetes infuscans)*	Sweet potato Fungus persists from season to season on diseased sweet potato roots. May overwinter in soils that are relatively high in organic matter.	Use disease-free roots for seed which can be produced from vine cuttings. Dip sprouts in fungicidal solution before planting. See recommended fungicides in Extension Bulletin 236.
SEED ROT	Beans (See DAMPING-OFF — Beans)	

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DISEASE	DESCRIPTION AND DAMAGE	CONTROL AND MANAGEMENT PRACTICES
SMUT *(Ustilago maydis)*	Sweet corn Fungus overwinters in the soil. Large, fleshy, irregular galls may be formed on leaves, stems, ears and tassels. The immature galls are white and spongy, and the mature galls turn brown and contain powdery, black spores of the fungus.	If practical, remove small galls as they form. Use long rotation. If possible, reduce insect injury. Use available resistant varieties.
SOUTHERN LEAF BLIGHT *(Helminthosporium maydis)*	Sweet corn Fungus overwinters in the soil in diseased plant refuse. Leaf spots are relatively small with sides of the spots parallel. Many spots coalesce and entire leaf is killed.	Use resistant varieties.
STEM ANTHRACNOSE *(Colletotrichum truncatum)*	Beans Fungus overwinters on and in lima bean seed, in other infected crops such as alfalfa and in crop refuse on surface of ground. Reddish blotches or streaks appear on the pods, stems, petioles and branches. Discoloration on leaves begins on lower leaf surface as reddening of veins or red spots.	Use western-grown healthy seed. Use 2-year rotation. Crop can be protected with recommended fungicidal spray. See Extension Bulletin 236.
VIRUSES	Beans Several virus diseases occur on beans. Some are seed transmitted. Others are spread by insects. General stunting of entire plant; puckering and stunting of leaves and distortion of pod.	Use disease-free seed. Use resistant or tolerant varieties.
	Tomato A number of viruses affect tomatoes. These viruses may overwinter in perennial weeds and some may be carried in the seed. Insect transmission is a factor in the spread of these viruses. Light and dark green mottling with curling and malformation of leaflets. Fruit may be mottled and malformed. Plant may be stunted or dwarfed.	Use disease-free seed to produce healthy transplants. Attempt to remove perennial weed hosts of viruses adjacent to tomato fields. Control insects, especially aphids, as soon as possible. Do not handle tobacco products when handling tomato transplants.

DISEASE	DESCRIPTION AND DAMAGE	CONTROL AND MANAGEMENT PRACTICES
WHITE MOLD *(Sclerotinia sclerotiorum)*	Beans Fungus overwinters in and near bean fields in refuse from diseased plants. White, cottony growth appears on pods and stems. Small, hard, black, seed-like structures form in the white mold growth. Rotted pods become wet and soft.	Plant in well-drained fields. Practice long rotation using non-susceptible crops. Chemical control using a systemic fungicide has been very successful. For specific recommendation, see Extension Bulletin 236.
WHITE POTATO VIRUSES	White potato A large number of viruses can affect potatoes. In most cases, these viruses overwinter in many perennial weeds, and insects transmit these viruses to potatoes. The viruses are carried in the tubers produced by infected plants. Appears as yellowing or light to dark green mottling of leaves. Leaf rolling, distortion of leaves, dwarfing and malformation of vines occurs.	Use healthy, disease-free tubers such as certified-seed potatoes which are produced in areas with a low incidence of viruses.
WILT	Beans (See PYTHIUM ROOT ROT — Beans)	
WIRE STEM	Crucifers (See DAMPING-OFF — Crucifers)	

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PLANT - INSECT INDEX

BEANS (Snap and Lima)
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- Spider mites

COLE CROPS (Cabbage, Broccoli, Cauliflower, Brussels Sprouts)
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- Cabbage looper
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CUCUMBERS, MELONS, SQUASH AND PUMPKINS
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TOMATOES
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VEGETABLE CROP INSECT PESTS

INSECT	DESCRIPTION AND DAMAGE	LIFE CYCLE AND HABITS	CONTROL AND MANAGEMENT PRACTICES
APHIDS *(Aphididae)*	Cole Crops (Cabbage, Broccoli, Cauliflower, Brussels Sprouts) Tiny, soft-bodied, green or bluish insects that cluster on leaves and suck plant juices causing leaves to curl and lose color.	All stages may occur annually and many may occur in a year. Aphids are unusual in that the female may produce young without mating. Also, they can produce young which are already hatched from the egg. During adverse weather conditions winged individuals may be produced. At certain times male and female aphids are produced, and these may mate and produce young.	Treat when aphids appear in clusters on leaves and repeat only if necessary. For recommended insecticides, see Extension Bulletin 236.
(Aphididae)	Cucumbers, Melons, Squash and Pumpkins Small, soft-bodied, greenish insects; usually found on undersides of leaves. They suck plant juices causing leaves to curl and lose color. Aphids may transmit a mosaic disease.	Overwinters in the egg stage. (See Aphids-Cole Crops life cycle.) Present from late May to September. Several generations are hatched a year.	Treat when they appear in clusters on leaves and repeat if necessary. For recommended insecticides, see Extension Bulletin 236.
(Aphididae)	Peas Small, soft-bodied, green insects that cluster on leaves and stems. Aphids suck plant juices, causing leaves to lose color. Plants may become stunted or die.	Overwinters in the egg stage or as an adult female primarily on leguminous plants. In the spring, winged females may be produced and migrate to pea fields. There are several overlapping generations a year.	Treat when aphids appear in clusters on leaves or stems and repeat only if necessary. For recommended insecticides, see Extension Bulletin 236.
(Aphididae)	Tomatoes Small, soft-bodied, green or pinkish insects that cluster on stems or leaves; cause leaves to curl, and plants to become stunted. Aphids may also transmit diseases.	Overwinters in the egg stage. (See Aphids - Cole Crops for typical life cycle.) There are several generations a year.	Treat when aphids first appear in clusters. Repeat in 7 days if necessary. For recommended insecticides, see Extension Bulletin 236.

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INSECT	DESCRIPTION AND DAMAGE	LIFE CYCLE AND HABITS	CONTROL AND MANAGEMENT PRACTICES
CABBAGE LOOPER *(Trichoplusia ni)*	Cole Crops (Cabbage, Broccoli, Cauliflower, Brussels Sprouts) Light green caterpillars up to 1½ inches long with three pairs of club-shaped prolegs on the hind end. They feed on undersides of leaves, making ragged holes and may also burrow into heads.	Overwinter as pupae in a transparent cocoon, usually attached to the host plant. The adult is a small grayish-brown moth with a silvery, figure-8 spot on the front wings. Eggs are small, round and greenish white in color. Eggs are deposited on the host plant. There may be several generations a year. Most abundant in July to September.	Treat when worms are very small and repeat every 7 days. For recommended insecticides, see Extension Bulletin 236.
COLORADO POTATO BEETLE *(Leptinotarsa decemlineata)*	Tomatoes Adults are bulky, yellow beetles with black stripes and are ⅜ inch long. Larvae or young are brick red and humpbacked; up to ⅜ inch long. Both adults and larvae chew foliage.	Overwinters as an adult several inches beneath the soil surface. Orange-yellow, cigar-shaped eggs are deposited in groups of 10 to 30 on the undersides of leaves. The brick-red, humpbacked larvae feed for 2 to 3 weeks before entering the soil to pupate. There are 2 generations a year.	Treat when beetles or damage appear and repeat in 7 to 10 days if necessary. For recommended insecticides, see Extension Bulletin 236.
CORN EARWORM *(Heliothis zea)*	Sweet corn Green, yellow, pink or brown caterpillars with light stripes and yellow heads; up to 1¾ inches long. They appear first on fresh silks and later feed on kernels near the tip of the ear.	Overwinters as a pupa 2 to 6 inches below the soil surface. The adult is a light tan moth. The eggs are half the size of a pinhead, round and yellow, and are normally deposited singly on fresh corn silks. The young feed on the silks and then burrow into the ear and feed on the kernels. There are 3 generations a year.	For recommended insecticides and timing of application, see Extension Bulletin 236. Information on this pest is also available through the Maryland Cooperative Extension Service Pest Management Program.

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INSECT	DESCRIPTION AND DAMAGE	LIFE CYCLE AND HABITS	CONTROL AND MANAGEMENT PRACTICES
CUCUMBER BEETLES *(Chrysomelidae)*	**Cucumbers, Melons, Squash and Pumpkins** Yellow to yellowish-green beetle with 3 stripes or with black spots on the back; 1/5 to 1/4 inch long. Adults feed on leaves, stems and fruits. They also transmit the organism that causes bacterial wilt.	Adult beetles overwinter under trash in hedgerows, woodland, etc. They emerge early in the spring and lay eggs in the ground around the base of plants. The larvae or young may feed on the roots or underground portions of the stem. There are 3 or 4 generations a year.	Treat when seedlings first emerge from soil. Repeat 2 or 3 times at 5-day intervals. Apply sprays in late afternoon to avoid killing bees. For recommended insecticides, see Extension Bulletin 236.
EUROPEAN CORN BORER *(Ostrinia nubilalis)*	**Sweet corn** Pale, pink or brownish caterpillars with dark brown heads. Up to 1¼ inches long. Borers tunnel and feed in stalks and may enter ears at base or tip.	Overwinters as a full-grown worm in the stems of host plants. It pupates in the spring and then emerges as a small, tan moth with dark wavy lines on the wings. Eggs are laid in groups of 10 to 50 on the underside of host plant leaves. The eggs resemble fish scales. The young worms feed on the leaves before boring into the stem and ears. There are 2 generations a year.	Sprays applied for corn earworm should protect the ears from European corn borers. For recommended insecticides, see Extension Bulletin 236. During the growing season, weekly information on this pest is available through the Maryland Cooperative Extension Service Pest Management Program.
FLEA BEETLES *(Chaetocnema pulicaria)*	**Sweet corn** Small, black, jumping beetles. They attack young plants and transmit a bacterial wilt disease.	Overwinters as an adult in hedgerows, along roadsides or along the edges of woodlands. Eggs are laid on the leaves or in the soil around the roots. Most of the damage on corn is caused by the overwintering adults. There are 1 or 2 generations a year.	Treat when plants first emerge from the soil and repeat 2 or 3 times at 5-day intervals. Beetles are numerous after mild winters. Plant bacterial wilt-resistant varieties of corn. For recommended insecticides, see Extension Bulletin 236.
(Epitrix spp.)	**Tomatoes** Small, black or brown, jumping beetles. They cause small round holes to appear in leaves.	(See FLEA BEETLES - Sweet corn for typical life cycle.) Present from May to July.	Treat new transplants when small holes first appear in leaves. Repeat only if necessary. For recommended insecticides, see Extension Bulletin 236.

INSECT	DESCRIPTION AND DAMAGE	LIFE CYCLE AND HABITS	CONTROL AND MANAGEMENT PRACTICES
HARLEQUIN BUG *(Murgantia histrionica)*	Cole Crops (Cabbage, Broccoli, Cauliflower, Brussels Sprouts) Adults and young are brilliantly colored with red or yellow; shield shaped; up to 3/8 inch long. Their feeding causes leaves to turn brown and plants to wilt.	Adults overwinter in the field or in rubbish. Eggs are laid in groups of 10 to 15 and are found on the undersides of leaves. Individual eggs resemble "kegs". The nymphs or young resemble the adults. There may be several overlapping generations a year.	Treat when bugs are first seen and repeat only if necessary. For recommended insecticides, see Extension Bulletin 236.
IMPORTED CABBAGEWORM *(Pieris rapae)*	Cole Crops (Cabbage, Broccoli, Cauliflower, Brussels Sprouts) Dark velvety-green worms up to 1½ inches long with 5 pairs of prolegs in addition to 3 pairs of legs. Their feeding injury is similar to that of the cabbage loopers. They riddle the leaves with large irregularly shaped holes. They may also burrow into the heads.	Insect overwinters in the pupal stage as a greenish chrysalid on or near the host plant. The adult is the familiar small, white butterfly with 3 or 4 black spots on the wings. Yellow, cigar-shaped eggs are laid singly on the undersides of host plant leaves. There are 3 or more generations a year. Heaviest populations are in July and August.	Treat when worms are very small and repeat every 7 days. For recommended insecticides, see Extension Bulletin 236.
MEXICAN BEAN BEETLE *(Epilachna varivestis)*	Beans (Lima and Snap) Adults are ¼ inch long, oval, copper-colored beetles with 8 small, black spots on each wing cover. Young are orange to yellow, fuzzy or spiny. Adults and young skeletonize foliage and pods.	Adults overwinter on the ground among leaves and rubbish. Hedgerows and woodland areas are favored overwintering sites. Orange - yellow, cigar-shaped eggs are deposited on the undersides of the leaves in groups of 40 to 50. Normally, there are 2 generations a year.	Treat when foliage damage becomes conspicuous and repeat only if necessary. Larvae appearing in late summer may be parasitized by a small wasp which is presently being released by the Cooperative Extension Service and the University of Maryland Department of Entomology. For recommended insecticides, see Extension Bulletin 236. During the growing season, weekly information on this pest is available through the Maryland Cooperative Extension Service Pest Management Program.

INSECT	DESCRIPTION AND DAMAGE	LIFE CYCLE AND HABITS	CONTROL AND MANAGEMENT PRACTICES
PICKLEWORM *(Diaphania nitidalis)*	Cucumbers, Melons, Squash and Pumpkins Whitish or greenish caterpillars ½ to 1 inch long; bore into the underside of fruit. These caterpillars are brownish at the head end.	Overwinters in the south and migrates to the north. The adult is a moth with transparent hind wings. Eggs are laid in groups of 3 to 10 on buds, leaves, stems and underside of fruits.	This pest is most serious in late season crops (August and September). For recommended insecticides, see Extension Bulletin 236.
POTATO LEAFHOPPER *(Empoasca fabae)*	Beans (Lima and Snap) Adults are green, wedge-shaped insects, up to ⅛ inch long. Nymphs or young resemble adults but are smaller. Both nymphs and adults cause leaves to curl or roll downward.	Most leafhoppers migrate up to the north from southern climates. Heaviest populations occur in late June to end of September. There are several generations a year.	Treat when leafhoppers are first seen, starting in June. Repeat in 7 to 10 days if necessary. For recommended insecticides, see Extension Bulletin 236.
SAP BEETLES *(Carpophilus lugubris)*	Sweet corn Adults are black or dark brown, 3/16 inch long. Larvae or young are cream colored and maggot-like; up to ¼ inch long. Both the adults, and larvae are found in the corn ears.	Overwinter as adults under trash. Adults appear in late June or early July. There are 3 to 4 generations a year. Most abundant from July to September.	Sprays applied for corn earworm should also control sap beetles. For recommended insecticides, see Extension Bulletin 236. During the growing season, weekly information on this pest is available through the Maryland Cooperative Extension Service Pest Management Program.
SPIDER MITES *(Tetranychus)*	Beans (Lima and Snap) Very tiny, spider-like creatures that feed on undersides of leaves. Heavy infestations cause plants to become stunted and unthrifty.	Overwinters in grass, weeds, hedgerows, etc. There are several generations a year. Heaviest populations are in July and August. Mites are favored by hot, dry weather.	Treat when foliage damage (stippling) appears and repeat in 7 to 10 days. Mites become abundant during hot, dry summer weather. For recommended insecticides, see Extension Bulletin 236.

INSECT	DESCRIPTION AND DAMAGE	LIFE CYCLE AND HABITS	CONTROL AND MANAGEMENT PRACTICES
(Tetranychus)	Cucumbers, Melons, Squash and Pumpkins Very tiny, spider-like creatures that feed on undersides of leaves. Heavy infestations cause leaves to lose color; plants become stunted and unthrifty.	(See SPIDER MITES - Beans.)	Treat when foliage damage (stippling) appears and repeat in 7 to 10 days. Mites are favored by hot, dry weather. For recommended insecticides, see Extension Bulletin 236.
TOBACCO HORNWORM *(Manduca sexta)*	Tomatoes Green, diagonally-striped caterpillars with prominent spine on rear end. They are up to 4 inches long and eat large quantities of foliage, often leaving only the stems.	Overwinters as a large, dark brown pupa in the soil. The adult is a moth often referred to as a hawk moth or hummingbird moth. These moths deposit greenish-yellow, round eggs, one in a place, on the undersides of leaves. The young feed ravenously for 3 or 4 weeks. There are 2 generations a year.	Treat when foliage injury is first noticed. For recommended insecticides, see Extension Bulletin 236.
TOMATO FRUITWORM *(Heliothis zea)*	Tomatoes (See CORN EARWORM - Sweet corn.) This is the same insect as the Corn earworm. The caterpillars bore pencil-sized holes in the fruit.	(See CORN EARWORM - Sweet corn.) There are 1 to 2 generations a year. Worms usually appear in July.	For recommended insecticides, see Extension Bulletin 236.

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CROP PLANT - WEED INDEX

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- Horsenettle
- Lambsquarters
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BEANS, SNAP *(Phaseolus vulgaris)*
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- Foxtail (Green, Yellow, Giant, Giant green)
- Galinsoga (Quickweed)
- Goosegrass
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- Pigweed (Hogweed, Amaranthus)
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CRUCIFERS
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- Tall Morningglory (Ivyleaf)
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- Ragweed
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TOMATO *(Lycopersicon esculentum)*
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VEGETABLE CROP WEED PESTS

WEED	DESCRIPTION AND DAMAGE	LIFE CYCLE	CONTROL AND MANAGEMENT PRACTICES
AMARANTHUS	(See PIGWEED)		
BLACK NIGHTSHADE *(Solanum nigrum)*	Leaves have entire leaf edge and alternate attachment on the stem. Leaf shape is oval with slightly toothed edge. Plant height is 1 to 3 feet. Flowers are in clusters and develop smooth, black berries.	A summer annual weed. All parts of the plant are poisonous.	Use specific herbicides for control.
BUTTERPRINT	(See VELVETLEAF)		
CANADA THISTLE *(Cirsium arvense)*	This is a large plant, 6 feet tall with deeply-notched leaves, 3 to 6 inches long and bristles on the leaf margins. The flowers are purplish-colored seed heads consisting of light, fluffy and chaffy seeds.	A perennial plant growing from underground rhizomes. Flower buds form at the same time peas are ready to harvest. This may contaminate the peas.	Use a postemergence phenoxy herbicide at the correct timing for both pea and weed size. Herbicides suppress bud formation. Rotate fields to other crops where more effective herbicides can be used for Canada thistle control.
COMMON LAMBSQUARTERS *(Chenopodium album)*	An annual weed with small, inconspicuous green bracts which are flowers. Leaves are variable in shape and size, usually 3 to 4 inches long, with a variable leaf margin from smooth to deeply notched. Stems have dark and light green stripes. Plant often grows 6 feet tall.	A summer annual weed. Less competitive in late summer than in early summer.	Use herbicides for control.
COMMON RAGWEED *(Ambrosia artemisifolia)*	An annual weed with strong odor from leaves which are tapered at the tip and deeply notched with numerous leaflets. It has a very small obscure flower and grows 6 feet tall.	A summer annual which germinates in the spring and summer.	Use recommended herbicides for control; cultivate and hand hoe as necessary.

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WEED	DESCRIPTION AND DAMAGE	LIFE CYCLE	CONTROL AND MANAGEMENT PRACTICES
COTTONWEED	(See VELVETLEAF)		
CRABGRASS, Large and Smooth *(Digitaria spp.)*	Large crabgrass has hairs on the leaf sheath, whereas smooth crabgrass does not. Both crabgrass types form roots at the nodes. Finger-like branches are from the seed head, but the spike-like branches are smaller in diameter than goose grass. Plant stems may be 3 feet in length.	A summer annual which becomes less competitive in late summer.	Use effective grass herbicides and cultivate early if necessary.
FALL PANICUM *(Panicum dichotomiflorum)*	In the seedling stage, the leaf sheath may appear purple. Leaves do not have hairs. Stem nodes are swollen, purplish in color, and roots may form on nodes. Branched, open seed head up to 1 foot in length. Stems may be ½ to ¾ inch in diameter. The leaves are ½ inch wide.	A summer annual which germinates early in the spring.	Use effective herbicides and shallow cultivation.
FOXTAIL, Green, Yellow, Giant, Giant green *(Setaria spp.)*	Stems are erect, 1 to 4 feet tall, with a dense spiklet and many seeds. The following leaf and spike characteristics may be used for identification: Foxtail's leaves and spike-like seed heads have the following characteristics: *Yellow foxtail* has hairs on the surface near the bases of leaves. *Green foxtail* has leaves with no hair and green, 2-inch seed heads. *Giant foxtail* has short and bristly hairs on leaf surfaces, and seed heads are green and 3 to 4 inches long. *Giant green foxtail* has leaves with no hair and 3- to 4-inch seed heads that are green with purple coloring on the spike.	A summer annual, competitive all summer.	Use effective grass herbicides and cultivate if necessary.

WEED	DESCRIPTION AND DAMAGE	LIFE CYCLE	CONTROL AND MANAGEMENT PRACTICES
GALINSOGA, QUICKWEED *(Galinsoga spp.)*	An annual with 1- to 3-inch long, oval-shaped leaves and is covered with small, ½ inch in diameter, yellow flowers. Weed is shaped like a bush up to 3 feet tall, and the first flowers usually occur when the plant is only 4 inches tall.	Germinates throughout the summer and early fall. Grows very fast and produces seed abundantly.	Weed is tolerant to many vegetable herbicides, and therefore, herbicides which selectively control galinsoga should be used (see herbicide and weed tolerance chart, Extension Bulletin 236). Tomato transplants should be checked for this weed before planting.
GOOSEGRASS *(Eleusine indica)*	Leaves are distinctly V-shaped, without hairs. When mature, the stems radiate outward from the center like the spokes of a wheel. Weed is often 2 feet tall but may also lie flat on the ground. It does not root at the stem nodes. Seed heads are finger-like (usually 4) at stem ends.	A summer annual which germinates in mid-May with arm soil temperatures. Extremely competitive until frost in late-planted crops.	Control with effective grass herbicides, and cultivate when in the first true leaf stage or sooner.
HOGWEED	(See PIGWEED)		
HORSENETTLE *(Solanum carolinense)*	Leaves are smooth or notched and 2 to 4 inches long. Stems and leaves have sharp spines. Weed has purplish or white flowers.	Horsenettle is a perennial, poisonous plant.	Use postemergence herbicides. Plowing will reduce the weed population.
IVYLEAF MORNINGGLORY	(See TALL MORNINGGLORY)		
JIMSONWEED *(Datura stramonium)*	A poisonous weed which germinates deep in the soil and makes control difficult. It has large, purplish, and trumpet-shaped flowers with strong scented leaves. It has large, 6-inch long leaves and spiny seed pods.	A summer annual weed.	Preemergence herbicide control is weak. Cultivate and hand hoe as necessary. Postemergence herbicides are most effective.
MALLOW	(See VELVETLEAF)		

WEED	DESCRIPTION AND DAMAGE	LIFE CYCLE	CONTROL AND MANAGEMENT PRACTICES
PEPPERWEED *(Lepidium virginicum)*	Weed initially forms a rosette of deeply notched, lobed leaves up to 4 inches long. Leaves are alternate and stems may grow to a 3-foot height. Seeds are round and flat and formed on a stalk-like cluster at the ends of the stems and branches.	A winter annual. Germinates during the fall and winter, and forms seed in the spring.	Use postemergence herbicides, and cultivate frequently.
PIGWEED, HOGWEED, AMARANTHUS *(Amaranthus retroflexus)*	Leaves are slightly tapered to oval-shaped. Large central stem is up to 2 inches in diameter at the base. Numerous small, green inconspicuous flowers are on a central flower stalk which matures into a bushy spike-shaped seed head up to 2 feet long.	A summer annual which may grow 6 feet tall.	Use recommended herbicides for control.
PURSLANE *(Portulaca oleracea)*	Weed has large, succulent, red stems. Leaves are ½ inch long, thick and juicy. A single plant may develop into a 5-foot wide mat of stems and leaves.	A summer annual.	This weed may be controlled by herbicides. Cultivate before seedlings are 1 inch in height.
QUICKWEED	(See GALINSOGA)		
SMARTWEED *(Polygonum spp.)*	An annual weed with tapered, long, narrow leaves with small pink or white flowers. It may grow 2 to 4 feet tall. The leaves are alternate on stems which may lie on the ground at the base.	A summer annual weed. Germinates very early in the spring.	Preemergence herbicides provide partial control. Cultivate when weeds are small because 4-inch tall plants are very difficult to control.

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WEED	DESCRIPTION AND DAMAGE	LIFE CYCLE	CONTROL AND MANAGEMENT PRACTICES
TALL MORNINGGLORY *(Ipomoea purpurea)* IVYLEAF MORNINGGLORY *(Ipomoea hederacea)*	Viney weeds with 2- to 3-inch long, heart-shaped leaves (tall morningglory) or three large lobes (ivyleaf morningglory). Seeds are poisonous. Flowers are large, 2 inches in diameter, white to blue color. Stem is hairy with alternate leaves.	Summer annual weed which grows and flowers all summer. Grows very small in late planted vegetables, but seeds are produced before frost.	Most vegetable herbicides do not control morning-glory with the exception of sweet corn. Timely cultivation when the morning-glory has just emerged is required.
VELVETLEAF, BUTTERPRINT, MALLOW, COTTONWEED *(Abutilon theophrasti)*	Most distinctive feature is a light green leaf, covered with fine hair and is soft to the touch. Grows to a height of 3 or 4 feet. An erect plant with a single main stem.	Summer annual which germinates in the spring.	Use recommended herbicides, and use proper timing with postemergence herbicides for best control.
YELLOW NUTSEDGE, NUTGRASS *(Cyperus esculentus)*	Leaves have a triangular shape in cross-section. Nutlets are formed at the ends of rhizomes. A dense, branched (2 inches in length) seed head is formed on a stalk.	A perennial weed which forms rhizomes and nutlets in August.	Nutsedge is usually controlled in vegetables with herbicides. See Extension Bulletin 236. For a high level of infestation, the nutsedge population should be reduced by growing corn in crop rotation since corn herbicides are available for effective control. In the spring, disc nutsedge-infested areas frequently to prevent the development of large plants because nutsedge plants over 5 inches tall are difficult to kill by tillage, and herbicides are also less effective.

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Solanum nigrum L. Black nightshade. *A*, Habit—× 0.5; *B*, inflorescence—× 2.5; *C*, seeds—× 5.

BLACK NIGHTSHADE

Cirsium arvense (L.) Scop. Canada thistle. *A*, Habit—× 0.5; *B*, head—× 1; *C*, flower—× 2.5; *D*, achene—× 3.

CANADA THISTLE

Drawings courtesy of Agricultural Research Service, U.S. Department of Agriculture.

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Chenopodium album L. Common lambsquarters. *A*, Habit, small plant; *B*, floral spike—× 2.5; *C*, flowers—× 7.5; *D*, utricle—× 4; *E*, seed—× 4.

COMMON LAMBSQUARTERS

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Ambrosia artemisiifolia L. Common ragweed. *A*, Habit—× 0.5; *B*, raceme with male heads (*above*) and female involucres (*below*)—× 2.5; *C*, leaf variations—× 0.75; *D*, achene—× 5; *E*, seed—× 5.

COMMON RAGWEED

Drawings courtesy of Agricultural Research Service, U.S. Department of Agriculture.

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CRABGRASS

Drawing courtesy of Jim Converse and O. M. Scott and Sons.

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Panicum dichotomiflorum Michx. Fall panicum. *A*, Habit—× 0.5; *B*, spikelet, showing the dichotomous florets—× 7.5; *C*, ligule—× 4; *D*, caryopses—× 7.5.

FALL PANICUM

Drawing courtesy of Agricultural Research Service, U.S. Department of Agriculture.

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A, *Setaria faberi* Herrm. Giant foxtail. *a*, Habit—× 0.5; *b*, spikelet, showing subtending bristles —× 5; *c*, ligule—× 1.5; *d*, caryopses—× 5. *B*, *Setaria viridis* (L.) Beauv. Green foxtail. *a*, Habit—× 0.5; *b*, spikelet—× 5; *c*, ligule—× 1.5; *d*, caryopses—× 5. *C*, *Setari glauca* (L.) Beauv. Yellow foxtail. *a*, Habit—× 1; *b*, spikelet—× 5; *c*, ligule—× 1.5; *d*, caryopses—× 5.

Galinsoga parriflora Cav. Smallflower galinsoga. *A*, Habit—× 0.5; *B*, enlarged flowering branch—× 2; *C*, flower head—× 4; *D*, ray flower—× 7.5; *E*, disk flower—× 7.5; *F*, achene with pappus—× 5.

FOXTAIL

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GALINSOGA

Drawings courtesy of Agricultural Research Service, U.S. Department of Agriculture.

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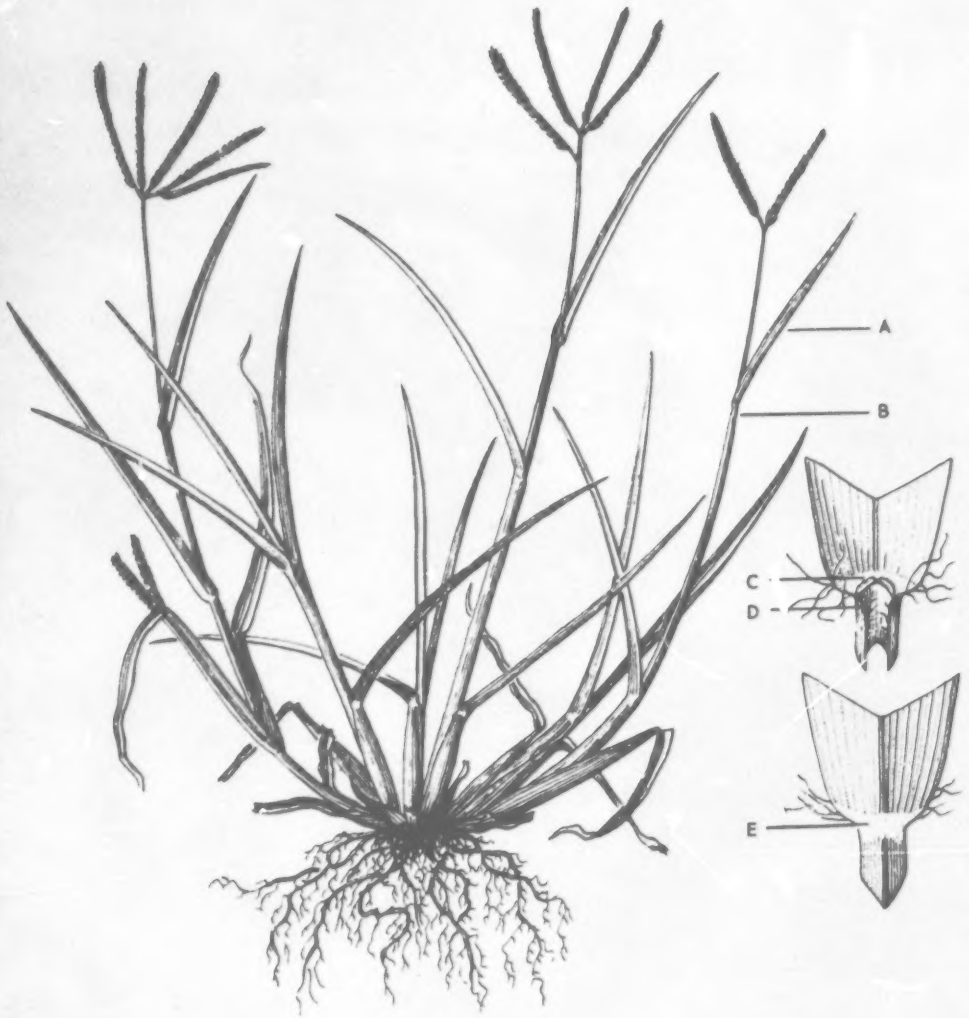
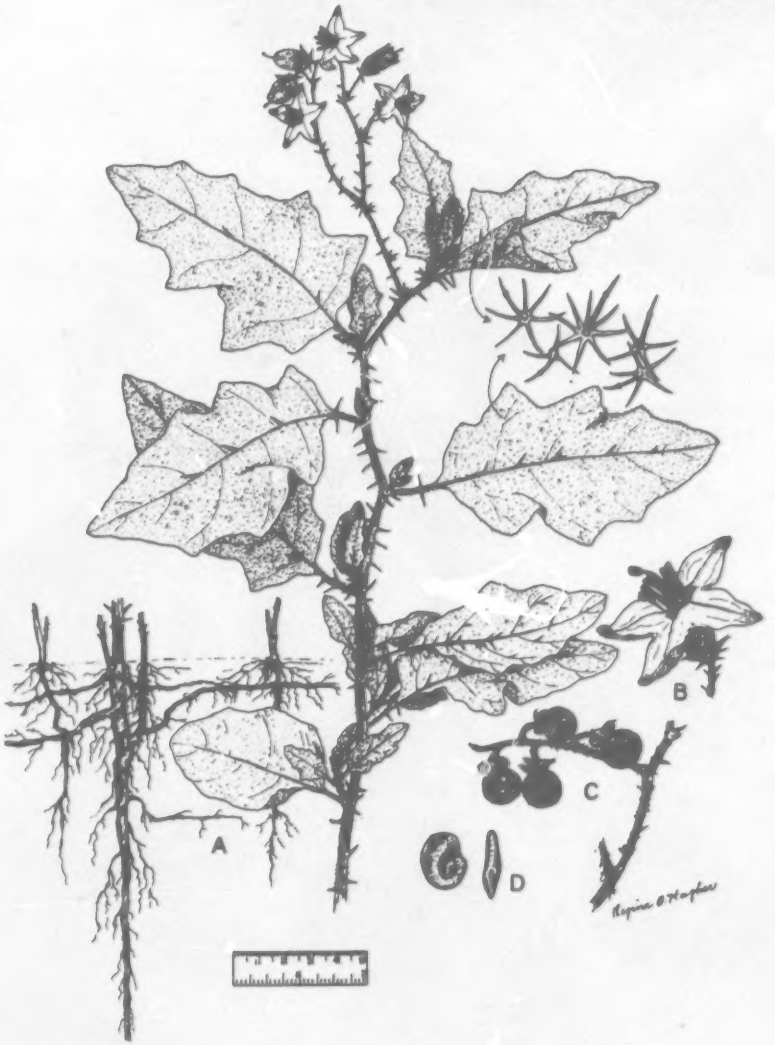


GOOSEGRASS

Drawing courtesy of Jim Converse and O. M. Scott and Sons.



Solanum carolinense L. Horsenettle. *A*, Habit—× 0.5; *B*, flower—× 1.5; *C*, berries—× 0.5; *D*, seeds—× 5.

HORSENETTLE

Drawing courtesy of Agricultural Research Service, U.S. Department of Agriculture.

Datura stramonium L. Jimsonweed. *A*, Habit, upper part of plant—× 0.5; *B*, cauline leaf—× 0.5; *C*, ripe capsule—× 0.5; *D*, seeds—× 3.

Lepidium virginicum L. Virginia pepperweed. *A*, Habit, upper part of plant—× 0.5; *B*, young plant, showing basal and cauline leaf forms—× 0.5 *C*, flowers—× 7.5; *D*, silicles, mature and immature—× 3; *E*, seed—× 10.

JIMSONWEED

PEPPERWEED

Drawings courtesy of Agricultural Research Service, U.S. Department of Agriculture.

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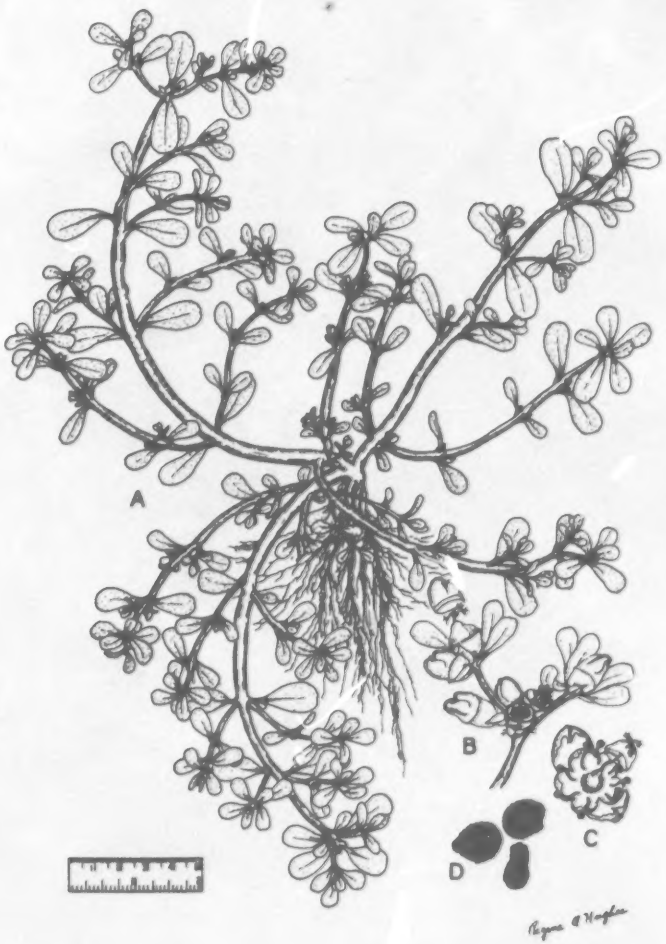
Amaranthus retroflexus L. Redroot pigweed. *A*, Habit—× 0.5; *B*, pistillate spikelet—× 5; *C*, utricle—× 5; *D*, seeds—× 3.



Portulaca oleracea L. Common purslane. *A*, Habit—× 0.5; *B*, flowers and capsules—× 1.5; *C*, flower open—× 4; *D*, seeds—× 18.

PIGWEED

PURSLANE

Drawings courtesy of Agricultural Research Service, U.S. Department of Agriculture.

Polygonum pensylvanicum L. Pennsylvania smartweed. *A*, Habit—× 0.5; *B*, spike—× 2.5; *C*, achenes—× 4.

Ipomoea purpurea (L.) Roth. Tall morningglory. *A*, Habit—× 0.5; *B*, flower diagram—× 0.5; *C*, capsule—× 0.5; *D*, seeds—× 3.

87 SMARTWEED

TALL MORNINGGLORY

Drawings courtesy of Agricultural Research Service, U.S. Department of Agriculture.

Ipomoea hederacea (L.) Jacq. Ivyleaf morningglory. *A*, Habit—× 0.5; *B*, sepals—× 1.5; *C*, capsule—× 2; *D*, seeds—× 5.

Abutilon theophrasti Medic. Velvetleaf. *A*, Habit—× 0.5; *B*, rootstock—× 0.5; *C*, flower—× 2.25; *D*, capsule—× 1; *E*, carpels—× 1.5; *F*, seeds—× 4.5.

IVYLEAF MORNINGGLORY

VELVETLEAF

Drawings courtesy of Agricultural Research Service, U.S. Department of Agriculture.

Cyperus esculentus L. Yellow nutsedge. *A*, Habit—× 0.5; *B*, spikelet—× 5; *C*, achene—× 10.

YELLOW NUTSEDGE
Drawing courtesy of Agricultural Research Service,
U.S. Department of Agriculture.